

In a secondary battery electric power storage system in a comparative  
 example 1, a <sup>secondary battery connection unit</sup> load 1 and a <sup>charge/discharge unit</sup> charge/discharge unit 2 are connected to a  
 secondary battery 3. The secondary battery 3 is connected to the  
<sup>connection unit</sup> charge/discharge unit 2 and the secondary battery 3 is charged with night  
 period rate electric power. Then, the secondary battery 3 is connected  
 to the <sup>secondary battery</sup> load 1 and the electric power stored in the secondary battery 3 is  
 discharged into the <sup>secondary battery</sup> load 1. After discharging, the secondary battery 3  
 is disconnected from the <sup>secondary battery</sup> load 1 and is connected to the charge/discharge  
<sup>unit 2 to</sup> unit 2 to charge the secondary battery 3 with night period rate electric  
 power. The <sup>residual capacity</sup> residual capacity of the secondary battery is determined by  
 subtracting a discharged capacity from an initial capacity. Fig. 9 shows  
 the difference between residual capacity indication and actual residual  
 capacity. As is obvious from Fig. 9, the difference increases as the  
 number of charge and discharge cycles increases and, consequently, accurate  
 residual capacity indication <sup>is impossible</sup> is impossible. Fig. 10 shows the charge and  
 discharge cycle characteristics of batteries. As is obvious from  
 Fig. 10, the capacities of a lead-acid battery, a nickel-cadmium battery, a  
 nickel-metal hydride battery and a lithium battery decrease greatly as  
 the number of charge and discharge cycles increases, and the lives of those  
 batteries are in the range of 500 to 700 charge and discharge cycles.

As is apparent from the foregoing description, according to the  
 present invention, the soundness of the battery can be secured, and  
 charging and discharging are carried out efficiently. The secondary  
 battery can be charged with inexpensive night period rate electric power in  
 the night and the surplus electric power can be supplied to loads in the day  
 time.

What is claimed is:

1. A secondary battery electric power storage system comprising:
  - a secondary battery connected to a load;
  - a detecting device for detecting a residual electric power of said secondary battery;

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a charge/discharge unit connected to a power source and to said secondary battery;

a control unit connected to said charge/discharge unit; and  
a signal line for transmitting information on said load  
and to said secondary battery to said control unit, wherein said charge/discharge unit discharges electric power of said secondary battery to said load when said residual electric power is larger than a predetermined value, and when the residual electric power is smaller than the predetermined value, the electric power is discharged to said power system or said load through said charge/discharge unit, prior to charging of said secondary battery.

2. A secondary battery electric power storage system according to claim 1, wherein said secondary battery is connected to a plurality of loads, and to said signal line, wherein said charge/discharge unit distributes electric power of said secondary battery among said loads when said residual electric power is larger than the predetermined value.

3. A secondary battery electric power storage system comprising: a secondary battery connectable to a load; a charge/discharge unit connectable to the secondary battery, said charge/discharge unit being connectable to a power system and either a plurality of loads or a plurality of electric power storage units; a detecting device for detecting a residual electric power in the secondary battery; and a control unit for controlling the charge/discharge unit on the basis of information from the secondary battery and at least one of the loads or electric power storage units, wherein electric power in the secondary battery is discharged to at least one of the loads when the residual electric power is larger than the predetermined value, and the residual electric power is discharged to the power system or to at least one of the loads or electric power storage units when the residual electric power is smaller than the predetermined value, prior to charging of the secondary battery.

4. A secondary battery electric power storage system comprising: a secondary battery connected to a load; a charge/discharge unit connectable to the secondary battery, said charge/discharge unit being connectable to a power system and either a plurality of loads or a plurality of electric power storage units; a detecting device for detecting a residual electric power in the secondary battery; and a control unit for controlling the charge/discharge unit on the basis of information from the secondary battery and at least one of the loads or electric power storage units, wherein electric power in the secondary battery is discharged to at least one of the loads when the residual electric power is larger than the predetermined value, and the residual electric power is discharged to the power system or to at least one of the loads or electric power storage units when the residual electric power is smaller than the predetermined value, prior to charging of the secondary battery.

5. A secondary battery electric power storage system according to claim 4, wherein said charge/discharge unit is connected to either a plurality of loads or a electric power storage units, and said wiring for signaling for transmitting information on either said loads or said electric power storage units and said secondary battery to said control unit, wherein said charge/discharge unit distributes electric power of said secondary battery among said either said loads or said electric power storage units when said residual electric power is larger than the predetermined value.

6. A secondary battery electric power storage system according to claim 3, wherein a signal line for transmitting at least either information about the operating condition of the plurality of loads connected to the charge/discharge unit or information about the surplus electric power stored in the secondary battery to the controller.

7. A secondary battery electric power storage system according to claim 1, wherein a computer measures the amount of electric power charged into the secondary battery and the amount of electric power discharged from

the secondary battery, and calculates the amount of residual electric power stored in the secondary battery.

8. A secondary battery electric power storage system according to claim 1, wherein a computer measures the amount of electric power charged into the secondary battery and the amount of electric power discharged from the secondary battery, and calculates the amount of residual electric power stored in the secondary battery, and an indicating unit indicates the amount of residual electric power calculated by the computer.

9. A secondary battery electric power storage system according to claim 1, the secondary battery is at least one of a lead-acid battery, a lithium battery, a nickel-cadmium battery and a nickel-metal hydride battery.

10. A secondary battery electric power storage system according to claim 1, wherein the charge/discharge unit comprises: a dc-ac conversion means, and a switching means for selectively connecting the power system to the secondary battery and the plurality of loads or to the plurality of electric power storage units.

11. A secondary battery electric power storage system according to claim 3, wherein the plurality of electric power storage units are at least lead secondary batteries, lithium secondary batteries, nickel-cadmium secondary batteries, nickel-metal hydride secondary batteries, heat storage and heat exchanger type electric power storage systems or superconducting type electric power storage systems.

12. A secondary battery electric power storage system comprising: a secondary battery connected to a load; a charge/discharge unit connectable to the secondary battery, said charge/discharge unit being connectable to a power system and either a plurality of loads or a plurality of electric power storage units; a detecting device for detecting a residual electric

power in the secondary battery; and a control unit for controlling the charge/discharge unit on the basis of information from the secondary battery and at least one of the loads or electric power storage units, wherein a controller that receives information from at least either the secondary battery or the plurality of loads and controls the charge/discharge unit; a computer that measures the amount of electric power charged into and the amount of electric power discharged from the secondary battery, calculates the amount of residual electric power stored in the secondary battery, and comprises a memory for storing measured data of the secondary battery and arithmetic program information, and a controller for processing the information stored in the memory or information given thereto from external devices, and an A/D converter through which information provided by the external devices is given to the controller, electric power in the secondary battery is discharged to at least one of the loads when the residual electric power is larger than the predetermined value, and the residual electric power is discharged to the power system or to at least one of the loads or electric power storage units when the residual electric power is smaller than the predetermined value, prior to charging of the secondary battery.

13. A secondary battery electric power storage system according to claim 12, wherein the secondary battery, the computer and the A/D converter are integrated.

14. A secondary battery electric power storage system according to claim 12, further comprising: measuring means for measuring data on discharge history including discharge current data, discharge voltage data and discharge temperature data and on charge history including charge current data, charge voltage data and charge temperature data; and a computer that receives information from the measuring means.

15. A secondary battery electric power storage system according to claim 12, wherein the memory stores information on a charging method specifying at least one of the intrinsic characteristics of the secondary battery including charging efficiency, discharging efficiency and temperature characteristic, and optimum charge conditions including a maximum charge capacity, a charge current, a charge time, a charge voltage and an upper limit voltage, and information on discharging method specifying at least one of optimum discharge conditions including a maximum discharge capacity, a discharge current, a discharge time, a discharge voltage and a lower limit voltage.

16. A secondary battery electric power storage system according to claim 12, wherein the memory unit stores an arithmetic program for determining discharge capacity by integrating discharge current data given to the A/D converter, an arithmetic program for determining charge capacity by integrating charge current data, an arithmetic program for determining a converted charge capacity determined by converting charge capacity in a real-time mode into available capacity at a discharging rate and a temperature condition when the discharge current data is received on the basis of the discharging efficiency and the temperature characteristic stored in the memory, and a program for calculating and indicating a residual capacity in a real-time mode by subtracting the discharge capacity determined in a real-time mode from the converted charge capacity determined in a real-time mode.

17. A secondary battery electric power storage system comprising a charge/discharge unit connectable to a power system, connectable at least either a plurality of loads or a plurality of electric power storage units and having connecting means to connect the charge/discharge unit to a secondary battery; characterized in that the charge/discharge unit is controlled by a controller on the basis of information received from the plurality of loads or electric power storage units, electric power in the secondary

battery is discharged to at least one of the loads when the residual electric power is larger than the predetermined value, prior to charging of the secondary battery.

18. A secondary battery electric power storage system according to claim 17, wherein an information transmitting means for interconnecting the controller and at least either the connecting means or the plurality of loads connected to the charge/discharge unit.

19. A method of operating a secondary battery electric power storage system comprising:

a secondary battery connected to a load;

a detecting device for detecting a residual electric power of said secondary battery;

a charge/discharge unit connected to a power source and to said secondary battery;

a control unit connected to said charge/discharge unit; and a signal line for transmitting information on said load and said secondary battery to said control unit, wherein said charge/discharge unit discharges electric power of said secondary battery to said load when said residual electric power is larger than a predetermined value and when the residual electric power is smaller than the predetermined value, the electric power is discharged to said power system or said load through said charge/discharge unit, prior to charging of said secondary battery.

20. A method of operating a secondary battery electric power storage system comprising a secondary battery connected to a load, and a charge/discharge unit connectable to a power supply system, the secondary battery and connectable to at least either a plurality of loads or a plurality of electric power storage units ; wherein feeding the residual electric power remaining in the secondary battery after feeding power to the load through the charge /discharge unit to at least either a plurality of loads or a plurality of electric power storage units ,when the residual

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electric power is larger than the predetermined value, prior to charging of said secondary battery.

21. A method of operating a secondary battery electric power storage system according to claim 20, wherein selecting a power receiving object and determining a feed power capacity on the basis of at least one of information about the surplus electric power stored in the secondary battery, information about the operating condition of the plurality of loads and information about the electric power storage condition of the plurality of electric power storage units; and feeding the surplus electric power to the selected power receiving object.

22. A method of operating a secondary battery electric power storage system according to claim 20, wherein the power receiving object is selected and the power feed capacity is determined on the basis of the information about the surplus electric power stored in the secondary battery, the information about the operating condition of the plurality of loads and the information about the electric power storage condition of the plurality of electric power storage units, after charging the secondary battery through the charge/discharge unit with night period rate electric power, and the surplus electric power is fed to the selected power receiving object in day period rate hours.

23. A method of operating a secondary battery electric power storage system according to claim 20, wherein selecting a power receiving object on the basis of surplus electric power remaining after feeding electric power to the load from the secondary battery and the operating condition of the plurality of electric power storage units after charging the secondary battery through the charge/discharge unit with night period rate power; and feeding electric power through the charge/discharge unit to the plurality of electric power storage units.

24. A method of operating a secondary battery electric power storage system comprising a secondary battery connected to a load,



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a charge/discharge unit connectable to a power supply system and connectable to the secondary battery, and a plurality of electric power storage units connectable to the charge/discharge unit in parallel to the secondary battery and connected to a plurality of loads, said method comprising: wherein electric power in the secondary battery is discharged to at least one of the loads or electric power storage units when the residual electric power is larger than the predetermined value, prior to charging of the secondary battery, charging the secondary battery through the charge/discharge unit with night period rate electric power, selecting a power receiving object on the basis of surplus electric power stored in the secondary battery after being charged with night period rate electric power, the power storage condition of the plurality of electric power storage units or the operating condition of the plurality of loads, and feeding electric power from the secondary battery through the charge/discharge unit to the selected power receiving object in day period rate hours.

25. A method of operating a secondary battery electric power storage system according to claim 20, wherein charging the secondary battery through the charge/discharge unit with night period rate electric power; selecting a power receiving object and determining power feed capacity on the basis of surplus electric power stored in the secondary battery after feeding electric power to the load, the power storage condition of the plurality of electric power storage units or the operating condition of the plurality of loads; and feeding electric power from the secondary battery through the charge/discharge unit to the selected power receiving object in day period rate hours.

26. A method of operating a secondary battery electric power storage system according to claim 20, wherein the secondary battery electric power storage system is provided with a memory connected with the secondary battery, at least optimum discharge conditions for the secondary battery are stored beforehand in the memory, and

the surplus electric power of the secondary battery is fed through the charge/discharge unit in a mode conforming to the optimum discharge conditions.

27. A method of operating a secondary battery electric power storage system according to claim 20, wherein the available discharge capacity or the possible discharge time of the secondary battery for the next discharge cycle estimated on the basis of the past discharge capacity, or the past discharge time and change of the discharge capacity, and the surplus electric power is discharged through the charge/discharge unit according to the estimated available discharge capacity or the estimated possible discharge time.

28. A method of operating a secondary battery electric power storage system according to claim 20, wherein the secondary battery electric power storage system is provided with a memory connected to the secondary battery, at least information about optimum charge conditions for the secondary battery is store beforehand in the memory, and the secondary battery is charged through the charge/discharge unit in a mode conforming to the stored optimum charge conditions after discharging the surplus electric power from the secondary battery.

29. A method of operating a secondary battery electric power storage system according to claim 20, wherein an available discharge capacity of the secondary battery for the next discharge cycle is estimated after discharging the surplus electric power on the basis of the past charge capacity, or charge time and change in the charge capacity, and the secondary battery is charged through the charge/discharge unit in a mode conforming to the estimated charge condition.

30. A method of operating a secondary battery electric power storage system according to claim 20, wherein the charge capacity of the secondary battery is stored in a memory, and the future available discharge capacity and the cycle life of the secondary battery are estimated on the basis of the change of the charge capacity in the past charge and discharge cycles.

31. A method of operating a secondary battery electric power storage system according to claim 20, wherein the secondary battery is at least either a nickel-cadmium battery or a nickel-metal hydride battery, and an amount of electric power in the range of 95% to 100% of a discharge capacity which can be discharged in a mode conforming to the optimum discharge conditions among the available discharge capacity for the next discharge cycle of the secondary battery is discharged as surplus electric power, when the residual capacity is in the range of 0% to 85% of the charge capacity.

32. A method of operating a secondary battery electric power storage system according to claim 20, wherein the secondary battery is a lithium battery, and an amount of electric power in the range of 80% to 95% of a discharge capacity which can be discharged in a mode conforming to the optimum discharge conditions among the available discharge capacity for the next discharge cycle of the secondary battery is discharged as surplus electric power, when the residual capacity is in the range of 5% to 80% of the charge capacity.

33. A method of operating a secondary battery electric power storage system according to claim 20, wherein, when discharging the surplus electric power through the charge/discharge unit after feeding electric power from the secondary battery to the load, the discharge of the surplus electric power after day period rate hours is stopped if the discharge of the surplus electric power has not been completed in day period rate hours, and the charge capacity is replaced with the charge capacity in the preceding charge cycle.

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